

Number 46

STROLLING STONES

THE MYSTERY OF

DEATH VALLEY'S

RACETRACK



by

Jean Johnson

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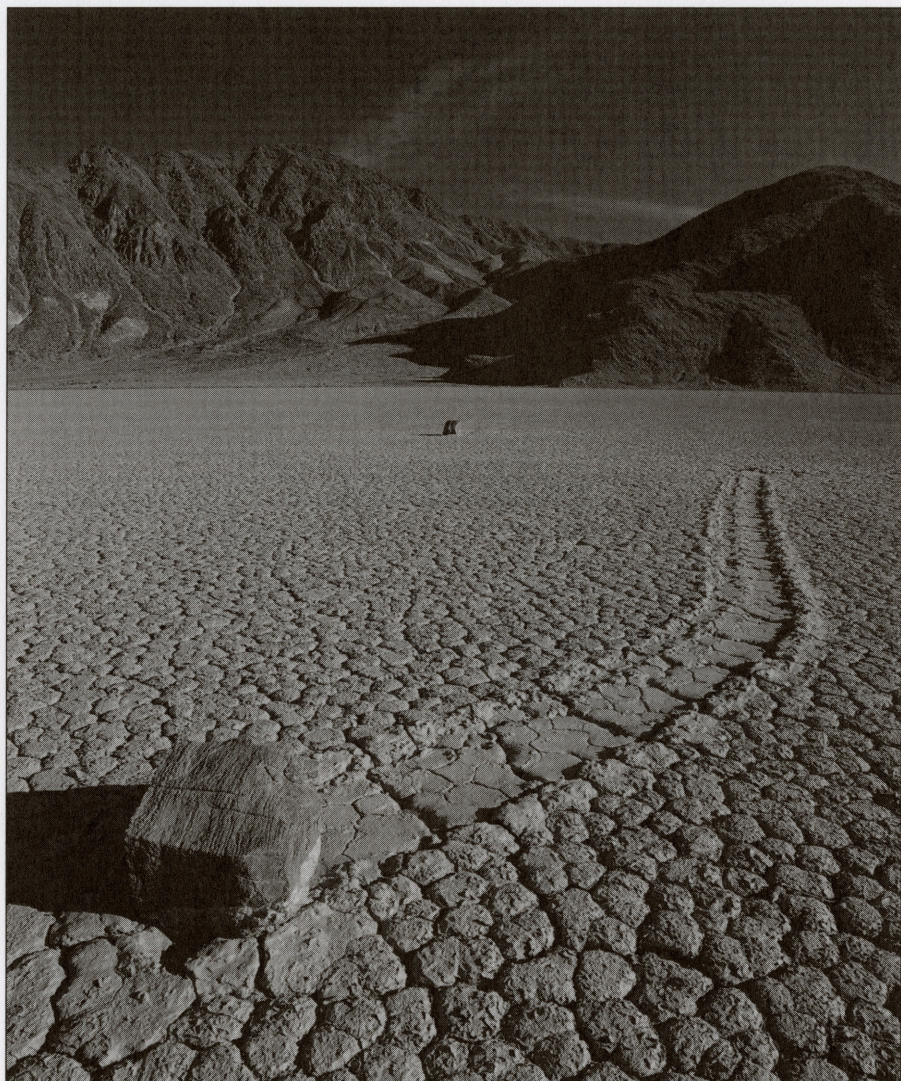
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A powerful stone and its lonesome trail through the “corn flake”-topped polygons of the Racetrack playa.

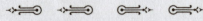
Courtesy © Tomaskaspar

My grateful appreciation to Dr. Paula Messina and her research predecessors for their work on the Racetrack stones and to the photographers who donated their glorious pictures. Jean Johnson

Cover photo: The picture is unusual in that the rock is sliding southeastward, opposite the usual direction, and the mountains in the background are north of Ubehebe Peak. 2005

Courtesy © Kit Hubert

I prefer that some things remain a mystery,
for if you know too much, the work
is no longer romantic.



Dr. Messina 1999

DEATH VALLEY is a land of many mysteries, and one of the most intriguing is the slithering of the silent stones, as one writer described it, on a plate-like playa called the Racetrack.

The word “racetrack” conjures visions of fast moving cars or horses—dust, noise, and collisions. But the Death Valley Racetrack, hidden deep in the Cottonwood Mountains, is a contradiction of the term. This racetrack is usually quiet as death with no motion visible at all. No bush to catch the breeze, no bird or insect to disturb the silence. Stillness, solitude, languor. These are words better suited to the Death Valley Racetrack.

This racetrack is an oval playa 2.8 miles long and 1.3 miles wide lying in the southwest-to-northeast-trending Racetrack Valley with Ubehebe Peak on the west.

No racetrack deserves the name unless something is racing around on it, and the Death Valley Racetrack has its racers—amazing stones that glide secretly about on its surface leaving furrowed tracks behind them. Some are fist-sized stones; some weigh as much as a third of a ton. No one knows how fast they move, but mud-splatters and wake-shaped residue imply some pretty fast stones—researcher Bob Sharp estimated a speed of 6 feet per second. And distance? In 2000, one stone left a new trail of 150 feet and another traveled 20 feet. In 1996 the longest trail ever mapped was about 2,886 feet, or over half a mile!

THEORIES

Is the playa a giant chess board with stones scattered across its surface like pawns for invisible Goliaths (maybe the Devil himself)?

What about magnetic pull as a force to move the stones? Problem is, the racetrack rocks do not contain much iron, so they can't be attracted by a magnetic pull. Not only that, many of the rocks have traveled opposite from magnetic north.

Some people think pranksters move the rocks, but such cannot be possible because their muddy tracks would be mute testimony to their crime. Also, trails ending at fresh burro dung and sticks imply that powers other than humans are responsible for moving the “terminal material.”



Racetrack from the air. Ubehebe Peak left, Dutton Mountains right, Grandstand upper-left playa, and dolomite "nursery" cliffs at bottom (south end) of racetrack, the source of most of the stones. Drawing shows location of stones numbers 86-105 and their trails on July 21, 1996.

Courtesy Paula Messina

The Death Valley region is a land of earthquakes; could the stones have been moved by land tremors? Scientists have marked the placement of stones and found them moved just weeks later when no land movement had been recorded.

Another explanation put forth is that the specific gravity of the saturated mud on the playa is sufficiently buoyant to lift the stones, ever so slightly, so they slide in the wind.

The following theories were proposed on the web page deathvalley.com/dvtalk:

➤ "I have it from a reliable source that the rocks get moved when the government test-flies the captured UFOs being held at Area 51. They tend to make tight turns over the Racetrack and the powerful

electromagnetic fields induced make the rocks almost weightless and gives them the needed motive force."



Racetrack playa with the grandstand visible in its northwest corner. Photo looking northwest from the top of the Dutton Mountains. Most of the strolling stones originate from "Moving Rock Ridge" at the south end of the playa.

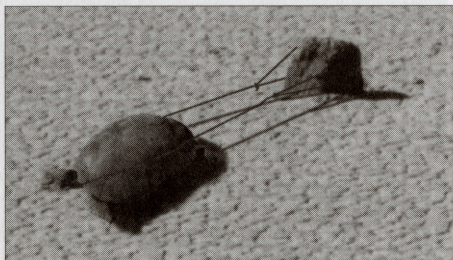
Courtesy Danny Ray Thomas

➤ “I wondered if the playa surface was being tilted somehow. Maybe the moisture in the playa freezes in the center first, and the whole thing bulges outward?”

➤ “When I worked on the flightline at Altus AFB in OK, we used 3-foot long wheel chocks to park C-5s.... [that] weighed around 80 lbs. On real windy days, they would take little strolls by themselves across the flat concrete.”

My favorite explanation is this one: The playa is a great nation made up of over a hundred colonies of microscopic beings, and each colony lives under its own special stone. They battle to see who can move their stone the farthest—and distance is the goal—not direction. After the contests, the colonies have a great celebration where, with flags flying, they march in the stones’ pathways as the judges measure the paths for length and quality.

The two dominant theories—movement by wind and the movement by ice—have been scientifically investigated since 1947. These theories are explored later; first, some background on the strolling stones and the playa where they live.



Tortoise caught in the act.

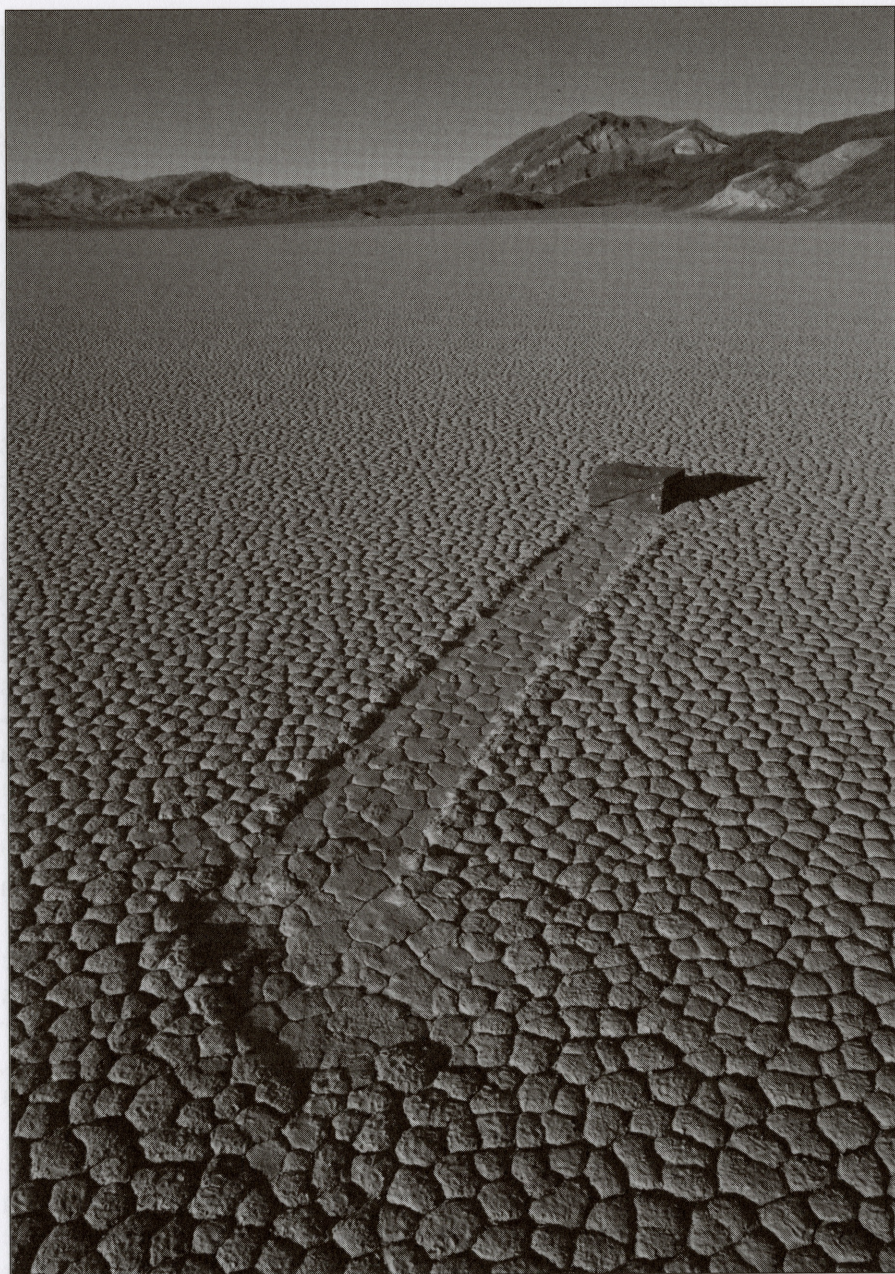
Courtesy Art Berggreen

THE RACETRACK PLAYA

One of the first things you notice about the playa is its cobbly-textured surface. It’s totally covered with polygonal sections of fine-grained sediments (dried mud) averaging about two inches in width, and the cracks separating these desiccation polygons go down about the same distance.

The millions of polygons are sometimes topped with breakfast food—that is, small, mud curls that look like corn flakes. Absence of these corn flakes can indicate that something—a rock, a twig, a pile of wind-blown mud—has scraped away the curls and left the polygons naked. Windrows of dried mud flakes litter the playa margins.

Getting to the Racetrack is hell on wheels. From the Death Valley side, it’s 27 miles over patches of tooth-sharp stones where geologist Paula Messina ruined 13 tires on her research trips to the playa.



This stone first made a large sitz mark, then dug even berms as it strolled over the cobbly surface of the playa.

Courtesy © Tomaskaspar

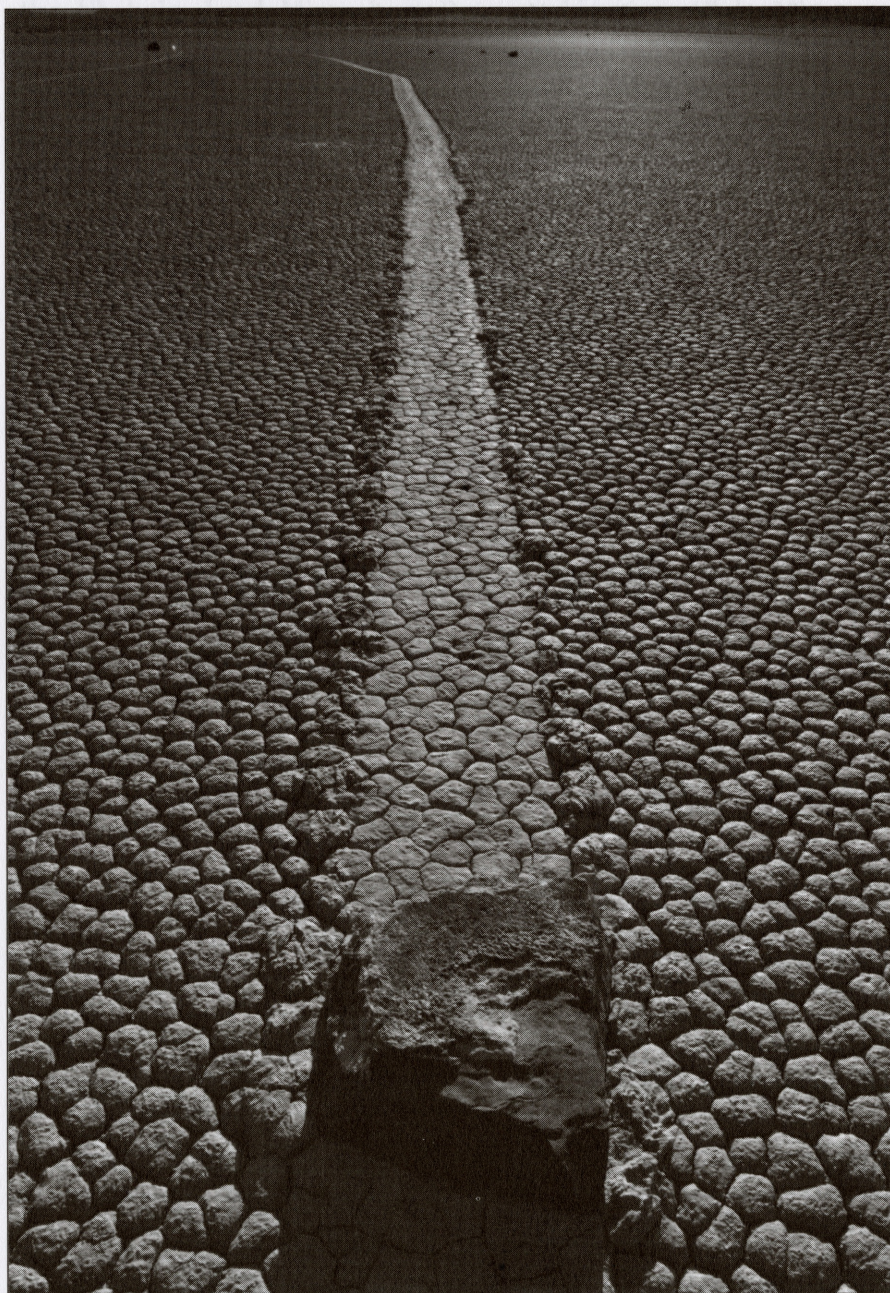
The playa is bounded by the Ubehebe Mountains on the west and the Dutton Mountains on the east, all within the larger Cottonwood Mountains, Panamint Range. Racetrack Valley used to be called Butte Valley, probably because of the "Grandstand," the 65-foot-high rock outcrop near the playa's northwest corner.

The mountains south of the playa are made of granitic rock (quartz monzonite) from part of the Jurassic Hunter Mountain Batholith, as is the Grandstand. Just northwest of the Racetrack is much older, light colored, Paleozoic sedimentary limestone and dolomite, some of which make up "Moving Rock Ridge," the bedrock rib at the south end of the playa where many of the sliding stones come from. The northwestern edge of the playa is at the base of Ubehebe Peak's granitic talus slope. Thus some of the mysterious moving rocks are dolomite (about 92 percent) and some are granite or quartz monzonite (about 8 percent).

The 1,650-acre playa is sometimes an ephemeral lake at 3,708 feet elevation; high enough for ice to form and snow to stick during cold winters. The south end of the playa is less than 2 inches lower than the north end almost 3 miles away; thus, for all intents and purposes, it is flat. It is assumed the valley receives about 5 inches of precipitation per year. It is composed of fine-grained sediments—about a quarter fine sand, a third clay, and the rest silt. During a rainstorm, there may be as much as 4 inches of water standing on the surface, which penetrates the surface to create an "exceedingly slippery shallow mud on a firm base."¹ The slipperiness is caused by the flat, plate-like particles sliding easily over one another. The firm substrate prevents the rocks from sinking into the mud.

Also, when wet, the clay swells and fills the cracks between the polygons to leave a smooth, slippery, slimy surface that remains from several hours to several days after a rainstorm. Later, water evaporates leaving the surface to crack again into polygons of hard, dried mud—the normal condition of the playa. The corn flakes form from the finest particles left on the surface as the mud dries.

In some places, mounds of sediment have been moved hundreds of feet leaving visible scars or trails. When water mixes with surface particles, a turbid liquid forms, and wind can propel these sheets of viscous, fine-grained sediments leaving tongues of silt, like sea-foam licking an ocean beach. These dried waves—"sliding glops"—and low sediment mounds on the playa are as interesting to see as the rocks.



Stone strolling (or racing?) on the Racetrack. Did this stone travel fast to create the bumpy berms bordering its long trail? When will it move again?

Courtesy © Tomaskaspar

Sticks, burro apples, and mounds of sediment are also subject to sliding across the Racetrack.

On the east-central curve of the playa two salty seeps supply water for brine shrimp, wild animals, and about 20 bushes. These depressions were dug out by ranchers driving cattle from Hunter Mountain to Goldfield, Nevada, in the early 1900s. A sinuous seep near the Grandstand stretches 782 yards southward with about 50 phreatophytes (deeply rooted plants that tap permanent water) marking its course. Both water sources are in line with the Basin and Range faulting in the area.

Temperatures at the Racetrack are a little lower than those at Scotty's Castle and are about 15° F below those at Furnace Creek.

Two natural wind funnels—from the southwest and, to a lesser extent, from the southeast—originating from Saline Valley, direct strong winds up the playa. Saline Valley is 1,640 feet lower, and as the air flows up and over the Racetrack Valley rim, it becomes compressed and thus moves more rapidly. Ninety-mile-per-hour winds have been measured at Owens Lake to the west, and winds are most likely more intense over the topographically-confined Racetrack. The greatest intensity occurs at the convergence of the wind tracks near the center of the playa.

In Panamint Valley there is little vertical or horizontal wind compression, but the Racetrack is narrower and the air is compressed by the surrounding mountains. Also, the Racetrack has a more uniform surface with no gullies or scattered bushes as is found on the Panamint Valley playa where rocks sink into the mud.

In the mountains surrounding the playa are signs of past mining. Gold and silver were mined as early as 1875, but the remote location limited production. With the increased price of copper in 1906, copper boomed in Greenwater and the Ubehebe area. The Ubehebe Mining District had numerous mines, and in 1907 promoter John Salsberry promised to develop two town-sites, a railroad, and a smelter. A good wagon road was built eastward to Bonnie Claire, and Salsberry and his financiers were selling bonds to build a railroad from Ubehebe to the Las Vegas & Tonopah RR at Bonnie Claire. However, a financial depression in late 1907 caused Governor Sparks to close the Nevada Banks; investment money dried up, and the inaccessible Ubehebe boom was a bust. Mining continued sporadically into the 1970s as various mines produced gold, lead, silver, copper, tungsten, and talc with increased activity during WWI. The best producing mines in the boom period were

the Ubehebe Lead Mine, Lost Burro gold mine, Ulida Mine, and Salsberry's Ubehebe Mining and Smelting Company. Years later, after WWII when the area was used as an aerial gunnery range, the Lippincotts reopened the Lippincott (Lead King) Lead Mine. Old ruins still dot the mountain landscape.

THE STONES

Joseph Crook, a Nevada prospector, gave the earliest documented account of the strolling stones in 1915, but they were not studied scientifically until about 1948. To this day, reasons for the stones' movements are not fully explained, and no one has seen them sliding silently on the slippery slime.

The Racetrack stones come from two sources: (1) weathered Jurassic granitic fragments from the alluvial fans and the Grandstand, and (2) dolomites (Racetrack Dolomite from the Paleozoic) from the "Moving Rock Ridge" at the southern end of the playa—the source of most of the strolling stones. (A very few banded limestone rocks originate from two knobs near the playa's northern margin.)

Researchers studied the stones' lithography—type, size, shape, location, and footprint (surface in contact with playa), to figure out what physical characteristics influence their movement.

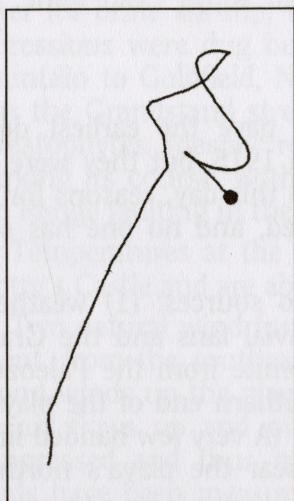
Dr. Paula Messina has done the most recent work on the racetrack (1990s). She mapped and measured 162 stones and their trails and gave them each a feminine name following the example of Robert Sharp who started the practice about 1968. Some of the names include: Colette, Danette, Theresa, Jacki, Amelia, Cynthia, Pamela, Ev, Fran, Mona, Robin, Hortense, Goldy, Dion, and Blanca.

The classification of stone sizes, from small to large, is: (1) very coarse pebbles (a cube 1.26 to 2.5-inches per side), (2) small cobbles (a 2.5 to 5-inch cube) (3) large cobbles (5 to 10-inch cube), (4) small boulders (10 to 20-inch), and (5) medium boulders (more than a 20-inch cube in volume).

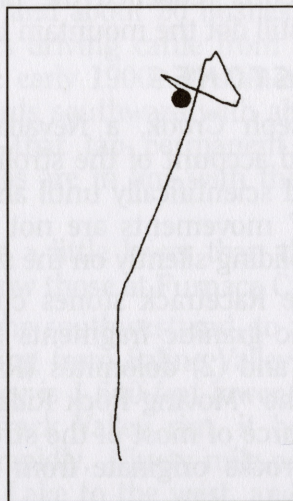
Paula Messina found only one very coarse pebble (Hanna) in 1996, 41 small cobbles, 69 large cobbles, 18 small boulders, and 3 medium boulders. Karen, Angel, and Kitty were the largest stones and classified as medium boulders. Tiny Hanna weighed .96 pound and robust Kitty, the heaviest, weighed in at 1,275 pounds!

The largest stones are found in the central region of the rock field north of the dolomite cliff "nursery." A variety of stone sizes

are found there, while in the eastern margin of the playa, stones are more similar in size.



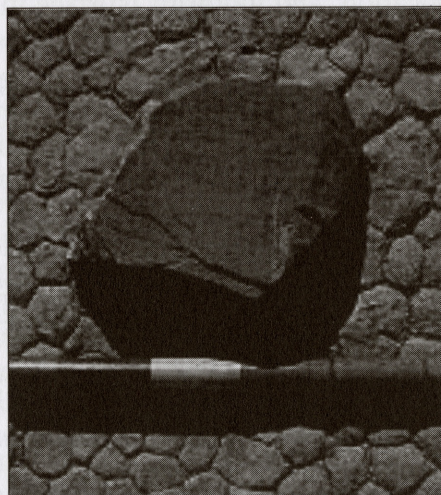
#026 Johanna 1,036 ft. trail



#029 Michelle 220 ft. trail



2.4"h x 9"l x 6"w at 13.5 lbs.



4"h x 14"l x 9"w at 56.6 lbs.

Note: Trail lengths illustrated are the total trail lengths as measured by Paula Messina in 1996. They are not to scale (i.e. Johanna and Michelles' trails look the same length in the illustrations, but Johanna's is 5 times longer than Michelle's.)



An admirer greets a strolling stone on Racetrack playa. 2004

© Tim Jones



Dolomite "nursery" cliff at south end of playa with a variety of stones and trails on playa.

© Tim Jones



Tracks going different directions may, or may not, be from different episodes of travel. © Tim Jones



What appear to be new parallel tracks head toward the mountains. 2005 © Tim Jones



Flotilla of strolling stone "wan'-ta-bes" head out then change direction like a school of fish. 2005 © Tim Jones



Two stones stroll out from the south shore on their maiden voyage. 2005

© Tim Jones



This strolling stone put a zig in its trail. 2004

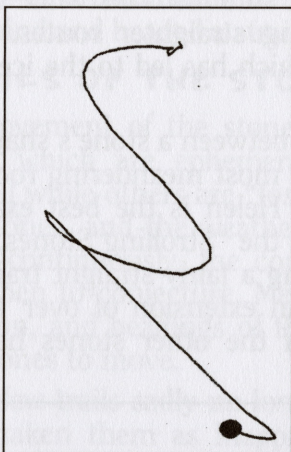
© Tim Jones



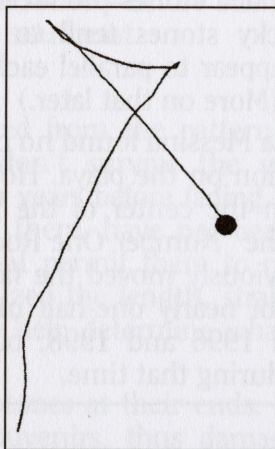
A determined stone wavers neither left nor right in its trajectory. 2004

© Tim Jones

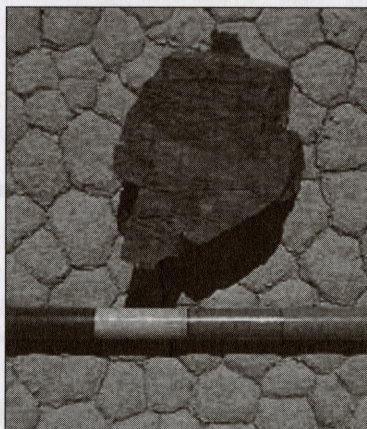
Contrary to what might be expected, Messina found that the largest (heaviest) stones do not always produce the shortest trails, and that the smallest (lightest) stones do not consistently produce the longest trails, (although small cobble-size stones averaged 833 feet, and the average trail length for the largest stones [medium boulders] was 348 feet).



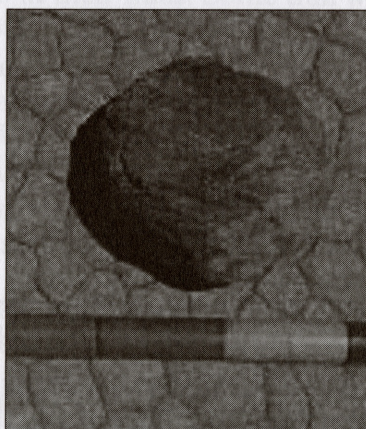
#035 Ev 487 ft. trail



#040 Fran 472 ft. trail



3.5" h x 10.5" l x 8" w at 31 lbs.



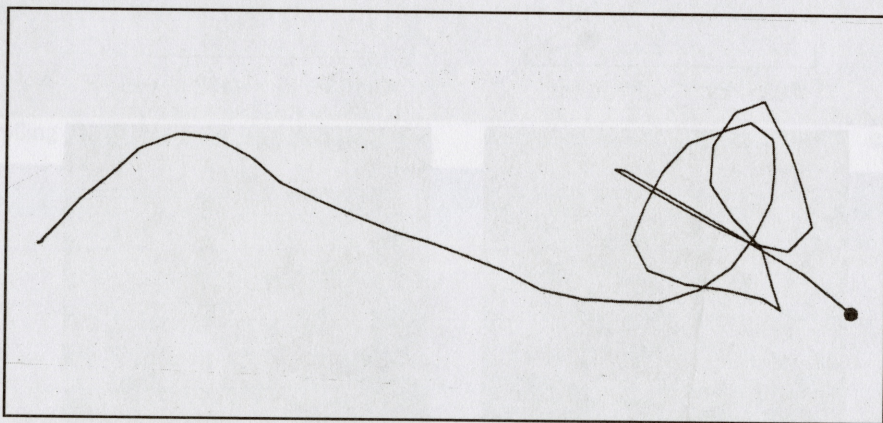
7" h x 8" l x 8" w at 43.5 lbs.

Stone length and height were also found to be unlikely factors affecting trail length. (The stones range in height from a little over one inch to over 22 inches high—Miss Kitty being the tallest.) In other words, the “sail” effect for taller stones was found to be negligible to producing a long trail.

A stone's *footprint*—its surface area in contact with the playa—contributes to friction between the stone and the surface. Most stones tend to be spherical rather than elongated, but there are notable exceptions. Most stones have 3 to 5 corners (noses) and no concavities, but Amanda, a flat slab of dolomite, has the most noses (9) and the most concavities (3).

Rounded stones produced the most sinuous trails while irregular, blocky stones tend to move along straighter routes. Some stones appear to parallel each other, which has led to the ice sheet theory. (More on that later.)

Paula Messina found no correlation between a stone's shape and its location on the playa. However, the most meandering rocks are found in the center of the rock field. Helen is the best example. Diane, the "Number One Rock Star" in the "Strolling Stones," who had previously moved the farthest along a fairly straight trajectory (a trail of nearly one-half mile), had an extension of over 19 feet between 1996 and 1998, but most of the other stones had not moved during that time.



#160 Helen—4" h x 9" l x 9" w at 35 lbs. Her trail is 494 feet. Can you follow Helen's convoluted path?

In 2000, two stones new to the data showed evidence of having traveled 150 feet and 20 feet respectively, but there were no visible previous trails. A gal on the move, Diane again made tracks prior to May 2001. Messina is able to measure stone locations and movements with accuracy down to an inch or so, and she wonders, now that the stones' movements can be investigated,... if they are "staying put because they know they're being watched?"

Although the stones move predominantly from southwest to northeast, there is an almost total lack of order. The paths zigzag, make complete circles, reverse their direction, turn at right angles, and crisscross one another. For instance, Pamela, Amelia, and Cynthia did a ballet, turning one way then the other, and finally heading in concert to the southeast. Helen made a complete circle—first counterclockwise then clockwise—before she made up her mind and headed a straight course southeast.

TRAILS OF THE STONES

Movement of the stones is inferred from the pattern of their trails, which are ephemeral; some don't survive the very next rainfall while others are "fossilized" for years before fading. Because the stones, and the weather affecting them, have not been monitored continuously, the conditions that permit them to move are still open to conjecture. Messina analyzed the length, straightness, location, and headings of the trails to help determine what causes the stones to move.

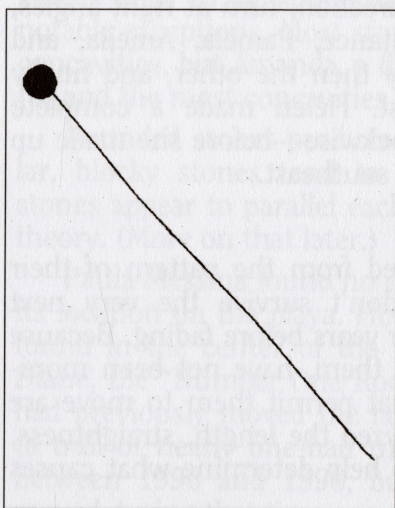
A few trails sadly no longer have stones at their ends. Humans have taken them as inappropriate souvenirs, thus damaging the mystery for the rest of us. Some stones take siestas in their meanderings and leave "sitz" marks in their trails. Some trail widths vary indicating that some stones rotate along their paths.

Trail Length — Over half the trails, in summer 1996, were under 218 yards in total length (about the length of two football fields), many doubling up or twisting and turning. Diane's trail was the longest, measuring 2,439 feet (almost half a mile).

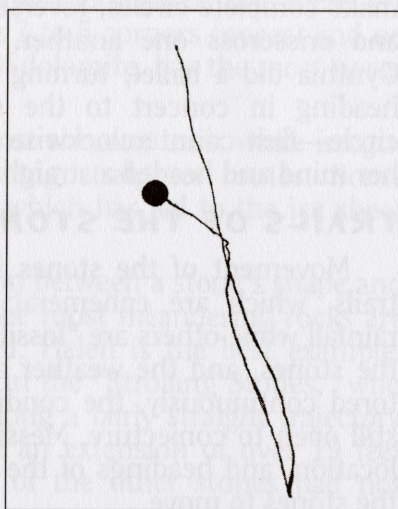
The average length depends on where they are located in the rock field. Those in the western section (closer to the road) are shorter than those farther east. Stones without trails are not considered, but they got there somehow. Presumably, they have not moved for such a long time their trails have melted into the past.

Trail Straightness — The majority of trails are quite straight with Agnes having the straightest one (a straightness coefficient of .99, with 1.00 being perfectly straight). Sheryl and Josephine at 85 feet and 276 feet respectively were runners up in straightness. Poor Claudia had the lowest score (total length 297 yards), but she headed back home and ended up only 56 yards from where she started. Her straightness coefficient is 0.19. However straight-laced Agnes traveled only 20 feet while Claudia, a rock hot-to-trot,

meandered 893 feet! The most meandering rocks were found in the central portion of the playa.



Straight-laced Agnes 20 ft. trail
1.5" h x 6" l x 2" w at 2.3 lbs.



Confused Claudia 893 ft. trail
16" h x 22" l x 16" w at 562 lbs.

Paula Messina found insignificant correlation between rock type and trail straightness, whereas Sharp and Carey thought trail length might be influenced by lithology (rock type) since granite rocks tend to weather into rounder shapes than carbonate rocks.

Trail Length versus Stone Footprint — The greater the contact between a stone and the playa surface the greater the frictional force to resist movement. Surprisingly, Messina found almost no correlation between trail length and footprint size.

Trail Length versus Stone Size — Finally we have a difference. Small and large cobbles (#2 & #3 in the size classification) are found most frequently in the northeast part of the rock field, and trails there are straighter than those found elsewhere. On average, the larger of the remaining stones (small and large boulders) tended to have straighter trails. Stones at the east side of the playa are smaller in general—76 percent of those at the east side are categorized as small cobbles. Their trails are generally longer and straighter, and they may be subject to more straight-line winds. Landforms bounding the Racetrack are as influential in stone movement as playa characteristics.

Trail Straightness versus Stone Shape — Stone shape seems to have little to do with trail straightness. The number of corners or

concavities to catch the wind didn't seem to matter. *Trail length and straightness are more dependent on the geographic location of stones on the playa and least dependent on the nature of the stone.*



This stone made an abrupt oblique-angle turn in its meandering. Why?

Courtesy © Tomaskaspar

Correlating Trails to Surrounding Terrain — Fifty-three percent of the motion of all the stones was toward the north-northeast, implying that most of the winds were from the south-southwest. Movement of the stones can be correlated to the orientation of the flanking terrain, which directs airflow onto the playa surface. Air movement is a complex phenomenon.

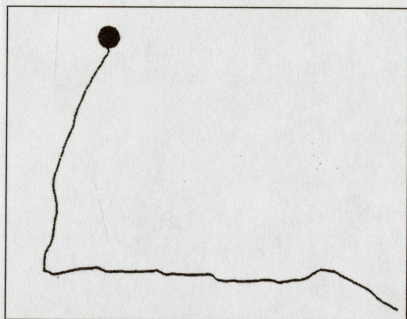
After analysis of her research, Paula Messina said, “the most surprising outcome...is the unanticipated *lack* of order in this natural system. Countless efforts to establish statistically significant relationships between rocks, trails and terrain characteristics yielded disappointing results.”

PAST RESEARCH

A number of scientists and interested folk have explored the silent, strolling stones from 1948 on.² Following is a brief review of that research.

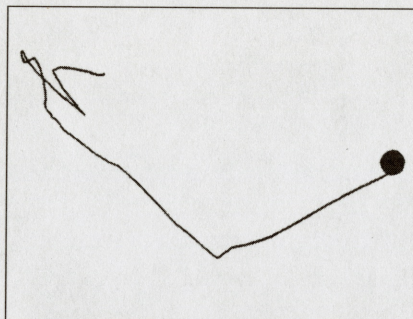
James McAllister and A.F. Agnew in 1948 first suggested dust devils as the force moving the stones. Louis T. Kirk, National Park

Service Ranger, used spring scales and a surveyor's chain to measure the trails in 1952, and John Shelton landed his plane on the playa to use its propeller as an artificial wind source to test his hypotheses. He flooded the surface around some of the stones but could not achieve a smooth, slippery film.

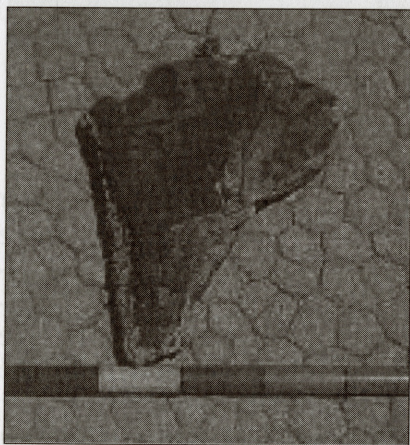


#042 Mona

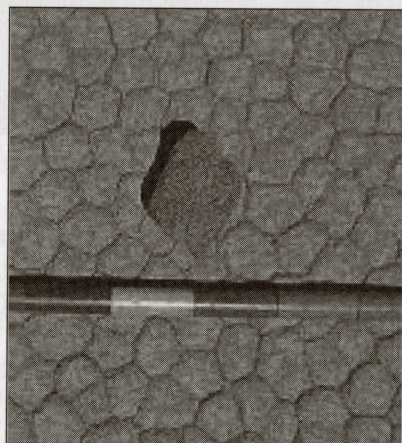
791 ft. trail



#054 Janet (granite) 486 ft. trail



5" h x 18" l x 13" w at 114 lbs.



3" h x 6" l x 4" w at 6.7 lbs.

Thomas Clements (1952) did most of his strolling stone research at Little Bonnie Clair Lake, while G.M. Stanley sketched the stones and their paths in 1955. Robert Sharp and Dwight Cary (1976) mapped a few groups of stone trails by putting stakes in the playa surface (no longer permitted) and measuring the movement during the following years. John Reid *et al.* (1995) used a theodelite to look at parallelism to support the ice-sheet theory.

S.A. Schumm tested the merits of ice floe and wind-only hypotheses in 1956, and W. E. Sharp (1960) worked on hydraulic-

like fluid pressure trapped by impermeable pores in the clay. E. Creutz (1962) felt the stones moved with gravity; that is, downhill, and tested the swelling of clays in his laboratory, but the gravity hypothesis couldn't explain all the trails.

Harold Bradley drove across the playa in 1956 and skidded across the wet spots where tongues of water stuck out on the playa. He could halt only after reaching the dry surface beyond. He found merit in both the ice floe hypothesis of Stanley and the "aeolian transport mechanism" (wind) supported by McAllister and Agnew.

Donald W. Carney, a Death Valley National Monument Ranger, correlated storms to stone movement. For instance, he observed that Hortense and Peggy were the only stones to make new trails in December 1970, after a heavy rain four days before.

The 1972-73 season must have had numerous winds from the north. Many stones traveled 90° from the norm by heading southeast, but some stones behaved themselves and continued northeast. In 1973-74, poor, confused Kristy slid 164 feet, then back south-southeast for 180 feet, coming to rest only 66 feet from her starting point. This was when 23 of the monitored 30 stones moved northeast. (Kristy's trail had "straightened out" by 1996.)

The research of John B. Reid *et al.*, favored ice rafts. Trails as much as 547 yards apart seemed parallel. Divergence of the trails was thought to be permitted by disintegration of the ice floe. Amazing parallelism was found when two trails were superimposed upon one another. Proponents of each theory (ice versus wind) found flaws in the reasoning of the other.

There was no complete survey of the stone trails until Paula Messina created the baseline for 162 stone positions and trail descriptions in 1996.

She put over 10,000 coordinates into the Geographic Information System (GIS) to an accuracy of 1.2 inch using Differential Global Positioning System (DGPS) for mapping. She and her assistant did most of their field work in summer of 1996, and walked over 100 miles back and forth on the playa measuring and observing the trails. Paula also built a terrain model of the surrounding topography to simulate nature's wind tunnels. She tested the mathematical formulas other researchers had used and analyzed their findings. She looked carefully at the wind versus ice theories, and with her more accurate measurements, found that parallel tracks—key to ice hypothesis, were not, in fact, parallel. Due

to restrictions in a wilderness area, she was not able to set up wind monitors, cameras, or other long-term measuring devices.

Paula Messina is the latest researcher to support the wind theory, although she does not dismiss the ice theory in very limited cases. She studied the source, direction, speed, compression, changes, and kinds of winds that howl over the Racetrack.

ICE THEORY

Ice proponents also include wind as a factor in moving their stones whereas the wind theorists believe wind (aided by a slick surface) pushes the stones. The ice theorists propose that ice sheets form on the lake bed in the winter and large sections break off. As they move, they provide the force needed to reposition a 700-pound rock on its fitful journey. The ice acts as a raft pushing the stones along as their undersides scrape the pathways—the stones act as sails, catching the wind.

Examples of parallel trails are most easily explained by ice holding the stones equi-distant from one another as the ice floe moves them along. Often these stone paths diverge, and this is explained by the ice floe breaking up and acting as separate ice rafts. The problem is that some of these tracks converge.

Messina's high-resolution dataset showed the trails with accuracy to about an inch and found that although some tracks appear parallel, they are not exactly parallel. She does not eliminate ice as a contributing factor but contends it's not necessary for stone movement.

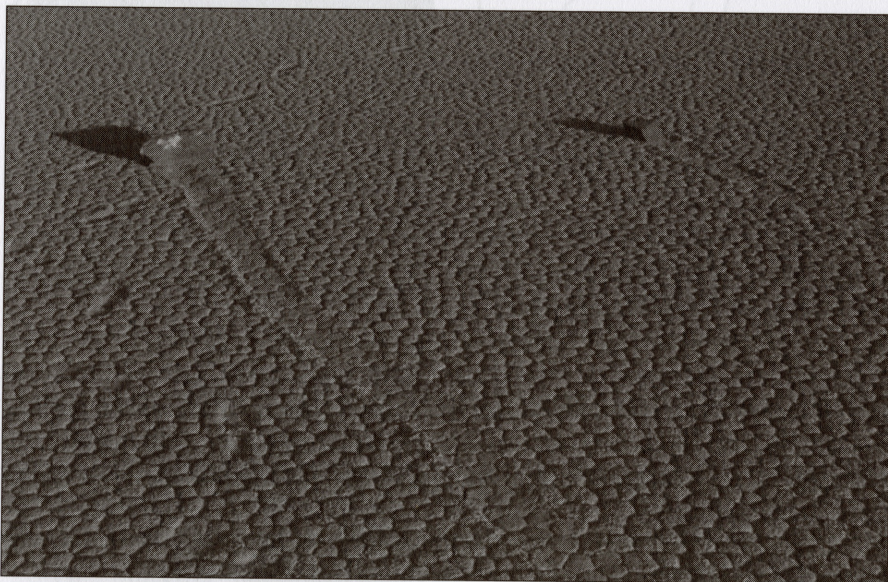
Some tracks widen, then become thinner as though the stones are rotating as they move. Some tracks twist and overlap in jagged patterns. These results would be unlikely if the stones were held rigidly within an ice floe.

WIND THEORY

Wind is a geologic agent that continually changes surfaces of the land. Long-term recording instruments cannot be installed within the wilderness area that includes Racetrack Valley (unfortunately for researchers), so the strolling stones and their tracks become their own recording devices.

The wind theory proposes that a damp playa surface, combined with high winds, provide the slippery surface and force required to move the stones.

There are all kinds of winds—straight-line winds, rotational winds, shearing winds, boundary-layer winds, and gusts. Winds are affected by the land features over and around which they must flow. The magnitude of wind velocity can be affected by the time of year, the time of day, and the storm front activity.

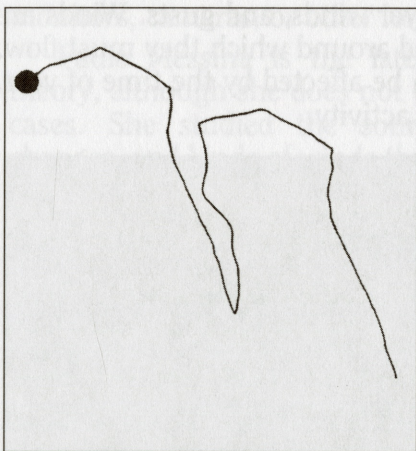


These two stones have slightly meandering trails. Note the boot racks made when the playa was damp.

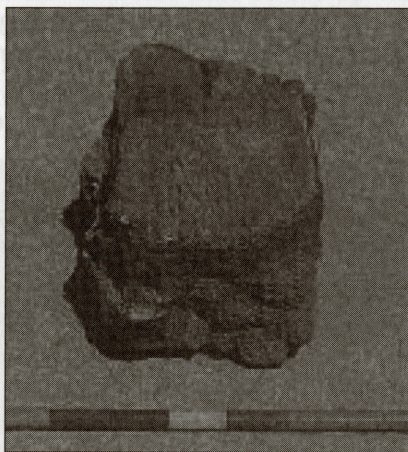
Photo © Tim Jones

A number of land features affect wind flow. Rough surfaces cause more turbulence than smooth surfaces, but they reduce the number and size of particles the wind can carry. Near-surface velocities are greatest near the center of very smooth lakebeds, and the center of the playa is where the largest rocks are found. Increased wind speeds are caused by compression of the air, both vertically (coming over the southern ridges) and horizontally (pressed in by the slopes on each side), and extreme gusts in highly localized areas are possible. For instance, Messina and her assistant, standing within 440 yards of one another with hand-held instruments, measured a 6-fold variation in simultaneous wind speeds. Thus a combination of channeled wind and convergence on a smooth surface may be major factors in stone movement.

Straight-line winds tend to separate particles whereas whirlwinds (including dust devils) can lift a broad spectrum of particles without regard to size, density, or shape.



#070 Linda 1,352 ft. trail



14"h x 22"l x 16"w at 492 lbs.

Low wind velocities move the fine-grained quartz sand found in dunes. Heavier particles require higher winds to move them. Seventy-five percent of the Racetrack's surface sediments are smaller than dune-size particles, but they are glued together more like concrete so they don't blow away. In addition, the Racetrack has little sand deposited on it even though quartz-rich source rocks are nearby. This implies high wind velocities.

Rotational winds "need to be considered as a significant component of rock activity" and may be responsible for moving the rocks in erratic patterns because these winds have both horizontal movement and vertical lifting power.³ Some rocks on the playa appear to exhibit "vortex activity"—convoluted scribbles found at the ends of several rock trails.

Unlike tornadoes and hurricanes, dust devils can spin in either direction. They are most common in mid-day in summer with relatively calm winds. Local spots can absorb solar energy resulting in high ground temperatures and the heated air rises. The column of air starts to spin when horizontal surface winds set it in motion. The vertical component of the air's movement lowers the air pressure even more at ground level. Most dust devils last less than a minute, and some are strong enough to move a pickup truck.

Maybe the theory of teeny-weeny critters moving the rocks isn't so far-fetched. Once water on the playa mixes with the finest clays on the surface (if the temperatures and conditions are right), there is likely to be a growth of native cyanobacteria. These growths

produce a nearly frictionless surface on the playa. It takes time for cyanobacteria (of the genus *Microcoleus*) to "bloom." Its filaments form a slippery, gelatinous sheath that leaves "pond paper," a paper-thin film, found dried on the trails. This gelatinous sheath is probably an important lubricant for stone movement.

CONCLUSION

The secret to the strolling stones is that surface conditions of the playa combine with powerful winds to move them. The stones almost "float" on the saturated mud as gale-force winds propel them—sometimes in straight lines, sometimes in more complex configurations.

Rock movement is influenced by cyanobacteria having time to bloom in water-saturated clay. Across this slippery surface, airflow is greatly increased by elevation, flatness of the playa, and the funneling configuration of the surrounding terrain.

Today the Racetrack is in a "non-invasive" wilderness research area and is recognized as a U.S. Biosphere Reserve. The Desert Protection Act of 1994 protects the playa and its strolling stones, but it also inhibits scientific study. (For instance, the stones cannot be radio-collared to monitor their movement when humans are away.)

Dr. Messina deserves the last word on the sliding, strolling stones: "The likelihood of future [strolling] events are dependent on the optimum combination of lubrication and wind climate."

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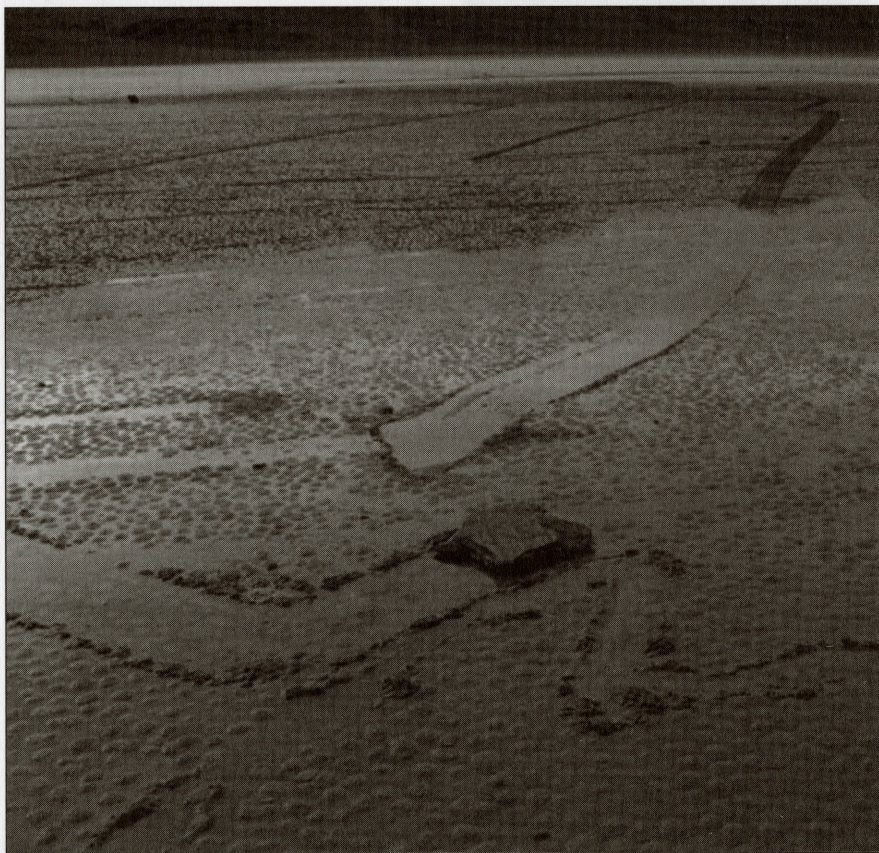
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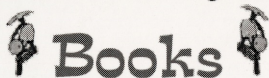
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This stone plowed up mud in front of it and covered part of a Z-shape track to its right; a neighboring stone has departed, leaving its own Z-shape track toward a distant resting place (upper right) as the breeze ripples a skim of water glistening on the storm-darkened playa. Other stones rest in the distance.

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